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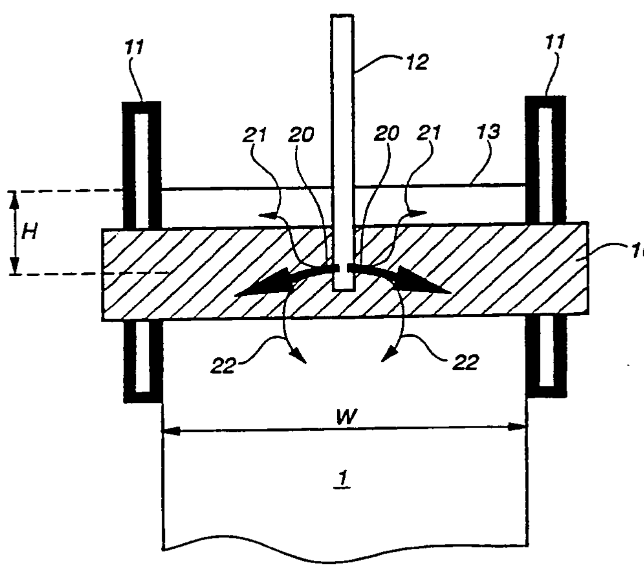

(57) Abstract

A method and a device for controlling the flow of the molten metal in non-solidified portions of a cast strand in connection with casting of metal. A mould (11) is supplied with at least one primary flow (20) of molten metal and at least one strand (1) is formed in the mould. At least one static or periodic low-frequency magnetic field (10) is applied to act with a maximum magnetic field strength in the mould exceeding 1000 Gauss in the path of the inflowing molten metal to brake and divide the primary flow (20) of molten metal flowing into the mould and to control any secondary flows (21, 22) arising. The static magnetic field (10) acts overessentially the whole width (W) of the cast strand (1) formed in the mould, whereby the magnetic field strength in a plane across the casting direction, on a level with the centre of the range of action of the magnetic field (10), varies within an interval of 60 to 100 per cent of its maximum value, while at the same time the field strength on a level with the upper surface/the meniscus of the molten metal amounts to at most 500 Gauss.

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A method and a device for casting in a mould

TECHNICAL FIELD

The invention relates to a method and a device in connection with casting of metals in a mould for controlling the flow of liquid metal in non-solidified portions of a cast strand by means of static magnetic fields arranged ajdacent to a mould used for forming the metal. Liquid metal - molten metal - flowing into the mould is slowed down and the flow of liquid metal in the non-solidified portions of a cast strand is controlled by controlling and distributing the propagation and intensity of the magnetic field, particles accompanying the molten metal thus being separated and floating up to the surface.

The invention is especially applicable to continuous casting in a chilled mould in which an uncontrolled inflow of hot molten metal, containing slag particles or other non-metallic particles, and/or an uncontrolled secondary flow entail problems both from the points of view of quality and production technique.

BACKGROUND ART

In continuous casting, hot molten metal flows, directly or through a casting tube, into a mould. In the mould the molten metal is cooled and a solidified, self-supporting surface layer is formed before the strand, the blank, leaves the mould. If inflowing molten metal is allowed to flow into the mould in an uncontrolled manner, it will penetrate, due to its impulse, deep down into the non-solidified portions of the strand. This renders difficult the separation of particles trapped in the molten metal, which adhere to the solidification front instead of being separated to the upper surface. In addition, the self-supporting surface layer is weakened, which increases the

risk of molten metal breaking through the surface layer formed in the mould.

From, for example, Swedish patent SE 436 251, it is known to arrange one or several static or periodic low-frequency magnetic fields in the path of the molten metal to brake and split up the inflowing molten metal. The magnetic fields are generated by means of magnetic poles, permanent magnets or induction coils supplied with direct current, and are arranged to act across the inflowing molten metal. The magnetic poles are arranged close to two opposite mould walls. However, the solution according to the above does not take into account any changes and unsymmetry in the flow configuration. Changes and unsymmetry in the flow configuration arise, besides in case of changed mould dimension and unsymmetrical location of the casting tubes, also by, for example, erosion and cloggings disturbing the flow out of the casting tube.

An unsymmetrical flow configuration entails great problems with regard to quality and production engineering; for example, hot molten metal, with or without non-metallic particles, may penetrate without being braked deep down into the non-solidified parts of the strand with ensuing quality problems. The upward flows of hot molten metal towards the upper surface, the meniscus, may become too weak, resulting in a risk of the meniscus freezing. If, instead, the upward flows become too strong, wave formation arises on the upper surface as a result of the turbulence, which pulls down slag from the upper surface into the molten metal with ensuing quality problems.

SUMMARY OF THE INVENTION

According to the invention, the flow of the molten metal in non-solidified portions of a strand is controlled in the casting of metal in which at least one strand - slab, bloom or billet - is formed in a mould which is downwardly open

and which, directly or through a casting tube, is supplied with at least one primary flow of hot, inflowing molten metal, by means of at least one static or periodic, low-frequency magnetic field. The static magnetic field is generated close to the mould by means of magnetic poles, permanent magnets or coils supplied with direct current. The mentioned static magnetic field is applied to act, with a maximum magnetic field strength in the mould exceeding 1000 Gauss, in the path of the inflowing molten metal to brake and split up the primary flow of molten metal flowing into the mould and thus prevent inflowing hot molten metal from penetrating deep down into the non-solidified parts, the sump, of the strand without being braked. At the same time part of the inflowing hot molten metal is controlled to flow towards the upper surface so as to obtain a desirable controlled circulation of molten metal in the non-solidified parts of the strand.

A controlled circulation of molten metal, a separation of particles trapped in the inflowing molten metal, and a controlled heat supply to the molten metal in the upper parts of the mould, without the turbulence close to the upper surface of the molten metal, the meniscus, becoming so great that waves are formed and particles are drawn down into the molten metal, are obtained by applying a static magnetic field, according to the invention, which in the mould has a maximum magnetic field strength exceeding 1000 Gauss. The static magnetic field is controlled and distributed, preferably by arranging the magnetic poles to be movable and/or providing them with adjustable core elements, to apply at least one static magnetic field to act over essentially the whole width, W, of the cast strand formed in the mould, the magnetic field strength varying within an interval of from 60 to 100 per cent of its maximum value in a plane across the casting direction, on a level with the centre of the range of action of the magnetic field while at the same time the magnetic field strength at the

upper surface/the meniscus of the molten metal amounts to 500 Gauss at the most.

When the variations in the field strength of the magnetic field are larger than those mentioned above in a plane across the casting direction, on a level with the centre of the range of action of the magnetic field, undesired secondary flows arise.

The magnetic field is suitably controlled and distributed so that the maximum field strength in the mould amounts to between 1000 and 2000 Gauss, preferably to between 1000 and 1800 Gauss.

To obtain a sufficient flow channel close to the meniscus and thus prevent this from freezing while at the same time the flow in these upper parts of the non-solidified portions of the cast strand does not become so strong that waves are formed on the upper surface of the molten metal, the meniscus, in the application of magnetic fields according to the invention the magnetic poles should be arranged such that the centre of the range of action of the magnetic field, its pole centre, is arranged at a distance of 300 to 600 mm below the upper surface of the molten metal, the meniscus.

To apply the magnetic field close to the mould, a magnetic circuit is required in which the magnetic field may flow around. Such a magnetic circuit may comprise, in addition to the magnetic poles and the static magnetic field arranged between the poles, a magnetic return path, preferably in the form of an externally applied magnetic yoke. In this way the necessary magnetic flux balance is achieved for a strand or a mould. It is, of course, possible to locate the magnetic field, with associated poles and yokes, so that magnetic flux balance is obtained for each mould half or for parts of a mould. The magnetic material included in the mould may advantageously be used as magnetic return path, and there-

fore, in many cases, special magnetic yokes are superfluous for obtaining magnetic circuits with magnetic flux balance.

According to a further embodiment of the invention, the distribution of the static magnetic field over essentially the whole width, W, of the strand formed in the mould is brought about by means of a pole plate arranged adjacent to a magnetic pole and a mould wall. The pole plates preferably extend along the long sides of the mould, Behind the pole plates a number of magnetic poles are arranged. Through the pole plates, magnetic fields from a plurality of magnetic poles are brought together and distributed to generate and apply a static magnetic field to act between the pole plates over essentially the whole width of the strand cast in the mould. In addition, by arranging pole plates the magnetic field is easier to adapt to variations in dimensions of the cast strand, for example the width of slabs in slabs casting.

The magnetic poles are preferably arranged according to the invention in water box beams arranged around the mould, or in a space between the water box beams and a frame structure surrounding them.

According to a previously described embodiment of the invention, the magnetic poles are arranged movable and/or with adjustable core elements. In this way, the propagation and intensity of the field can be controlled and distributed to ensure a good control of an incoming primary flow and secondary flows arising, in spite of the mounting limitations which exist in currently used conventional continuous casting moulds. The magnetic poles, in the form of loose coils or permanent magnets, are arranged in slots or on support beams arranged in or near the water box beams arranged around the mould.

According to an embodiment described above, the static magnetic field can be controlled and distributed by arranging the magnetic poles with adjustable core elements.

With magnetic poles in the form of coils supplied with direct current, this control is achieved by arranging the core of the coil with magnetic and non-magnetic sections which are inserted and replaced alternately to change the geometry of the coil core and hence the propagation and intensity of the magnetic field generated by means of the coil.

With magnetic poles in the form of permanent magnets, the above-mentioned control is achieved by providing a pole core, arranged between the permanent magnet and the mould, with magnetic and non-magnetic sectiosn which are inserted and replaced alternately to change the geometry of the pole core and hence the progation and intensity of the magnetic field generated by means of the permanent magnet.

Flow is an inert phenomenon, with a time constant of 10 seconds or more, and therefore intensity and direction of the static magnetic field can advantageously be adapted to vary in time, with a low freqency, to control the impulse of secondary flows arising.

By the invention, the movements of the molten metal in the non-solidified parts of the cast strand are controlled. Quality improvements are obtained since the separation of non-metallic particles is improved while at the same time the structure of the solidified metal is controlled. In addition, improvements from the production point of view are obtained since the risks of remelting of the solidified surface layer or freezing of the upper surface of the molten metal are essentially eliminated, which is reflected in increased productivity in the plant as a result of improved availability and increased casting speed.

BRIEF DESCRIPTION OF THE DRAWING

A static magnetic field for controlling the flow in non-solidified portions of a cast strand during casting in a mould is shown in Figure 1, the magnetic field being adapted to act over essentially the whole width of a strand formed in the mould and the propagation and intensity being controlled and distributed according to the invention. Figures 2 to 5 show how magnetic poles, in the form of movable and/or adjustable magnetic poles, according to various embodiments of the invention are arranged in relation to the mould, water box beams arranged near the mould and a frame structure arranged around the water box beams.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In continuous casting of at least one cast strand in a mould, at least one static magnetic field 10 is applied, as is clear from Figure 1, to brake and split up the molten metal flowing into the mould 11 through at least one primary flow 20 and to prevent the primary flow 20 of hot molten metal, which usually contains non-metallic particles, from penetrating deep down into the non-solidified parts of the cast strand 1. The molten metal can be supplied to the mould 11 through a free molten metal jet but is preferably adapted to be supplied through a casting tube 12. The casting tube 12 is providec with an arbitrary number of outlets, directed in an arbitrary manner, and is arranged preferably centrally in the mould 11. However, for different reasons, the primary flow 20 of iflowing hot molten metal will in many cases become unsymmetrical. According to the invention, therefore, one or a plurality of static magentic fields 10 are adapted to act over essentially the whole width, W, of the strand 1 formed in the mould 11. This slows down the primary flow 20 and divides it into secondary flows 21, the flow of which is controlled, and a controlled circulation of molten metal in the non-solidified portions of the strand 1 is obtained,

which entails a good separation of any accompanying particles, a good control of the casting structure as well as good conditions for increased productivity.

By arranging the static magnetic field 10, according to the invention, with the centre of its range of action, its pole centre, at a distance, H, of 300 to 600 mm below the meniscus 13, a flow channel is obtained near the meniscus 13. This flow channel ensures a sufficient heat supply to the upper surface 13 of the molten metal to prevent this from solidifying without the turbulence and the wave formation near the upper surface 13 becoming too strong with an ensuing risk of slag being drawn down into the molten metal. In addition, it is ensured that non-metallic particles are separated and float up to the slag layer positioned on the upper surface 13.

According to the invention, the intensity and propagation of the magnetic field 10 are controlled and distributed such that the maximum field strength in the mould exceeds 1000 Gauss. Suitably, the maximum field strength in the mould should be kept within an interval of 1000 to 2000 Gauss, preferably within an interval of 1000 to 1800 Gauss. According to the invention, the field strength of the applied magnetic field 10, in a plane across the casting direction over the whole width of the cast strand 1 formed in the mould 11 and on a level with the centre of the range of action of the magnetic field, the pole centre, may vary within an interval of 60 to 100 per cent of the maximum field strength without the undesired, uncontrolled secondary flows arising.

As will be clear from Figures 2 to 5, continuous casting moulds usually comprise an inner chilled mould 11, preferably a water-cooled copper mould. The mould 11 is surrounded by water box beams 14, which in turn are surrounded by a frame structure 17. To bring about a control of the flow of the molten metal in the non-

solidified portions of a strand 1 cast in the continuous casting mould, according to the invention, magnetic poles 15 are arranged in or near the water box beams 14 surrounding the mould 11 (see Figure 3). Alternatively, the magnetic poles 15 are arranged between the water box beams 14 and the frame structure 17 surrounding the water box beams 14 (see Figure 5). According to the invention, magnetic poles 15 are adapted to generate a static magnetic field 10 with a field strength whose intensity and propagation are controlled and distributed to act over essentially the whole width W of the strand 1 cast in the mould 11 and with a maximum magnetic field strength exceeding 1000 Gauss, while at the same time the magnetic field strength on a level with the meniscus has a maximum value of 500 Gauss. The frame structure 17 is provided with a magnetic return path 18, shown in the figures as an iron core provided in the frame structure 17, which together with the magnetic poles 15 and the magnetic field 10 acting between the poles 15 forms a magnetic circuit for the mould 11. The magnetic poles 15, the magnetic field 10 and the iron core 18 may, of course, be arranged such that circuits with magnetic flux balance are obtained for each mould half or for minor parts of the mould 11.

A construction as described above may entail considerable limitations of the possibility of inserting magnetic poles 15 in the form of both magnetic coils and permanent magnets, especially since a static magnetic field 10 covering essentially the whole width W of the cast strand 1 formed in the mould 11 is desired and where the intensity and propagation of the static magnetic field are controlled according to the invention. To overcome such limitations, the magnetic poles 15 are arranged, in one embodiment of the invention, movable in slots in the support beams 14 of the mould (see Figure 3). Alternatively, the movable magnetic poles 15 may be arranged between the water box beams and the surrounding frame structure 17 (see Figure 5). With magnetic poles 15 arranged movable, the intensity and propagation of the

static magnetic field 10 can be easily changed in case of changes of the flow configuration, for example as a result of dimensional variations, preferably width variations, of the cast strand.

To further improve the possibilities of controlling and distributing the propagation and intensity of the magnetic field 10, according to one embodiment of the invention the magnetic poles 15 are provided with adjustable core elements 19, in the form of both magnetic and non-magnetic sections. The core elements 19 are adapted to be alternately inserted/replaced to change the propagation and intensity of the magnetic field 10. With magnetic poles 15 in the form of induction coils 15a supplied with direct current (see Figure 3), the core 151 of the coil is provided with adjustable core elements 19 of both magnetic and non-magnetic material. In this way, the possibilities of controlling the intensity and propagation of the magnetic field 10 generated by means of the induction coil 15a are increased. With magnetic poles 15 in the form of permanent magnets 15b (see Figure 5), a pole core 152 is arranged between the permanent magnet 15b and the mould 11, the pole core 152 consisting of magnetic and non-magnetic core elements 19 which are inserted/replaced to change the magnetic field 10 generated by the permanent magnet 15b. The use of permanent magnets 15b/induction coils 15a is, of course, not connected to the installation design in which they are exemplified but the type of magnetic pole 15 and the installation design can be replaced independently of each other.

Figures 2 to 5 also show how, according to one embodiment of the invention, pole plates 16 are arranged adjacent to two sides of the mould 11 positioned opposite to each other. The pole plates 16 are adapted so as to extend along the sides of the mould 11. Behind the pole plates one of more magnetic poles 15 are arranged in the form of coils supplied with direct current, or permanent magnets. The fields from

these magnetic poles 15 are brought together and distributed to generate and apply a static magnetic field 10 with a maximum field strength amounting to at least 1000 Gauss, suitably to between 1000 and 2000 Gauss, preferably to between 1000 and 1800 Gauss.

A static magnetic field 10, applied, controlled and distributed according to the invention, prevents molten metal from penetrating down into the cast strand 1 without being braked, while at the same time providing a control of the flow of the molten metal in non-solidified portions of the cast strand 1. In addition, it is ensured that non-metallic particles contained in the inflowing molten metal are separated towards the upper surface 13, that the upper surface/the meniscus 13 is supplied with a sufficient amount of hot molten metal not to solidify, and that the turbulence and wave formation at the meniscus are essentially avoided, which eliminates the risk of casting powder/slag being drawn down from the slag layer positioned on the upper surface 13. All in all, a better yield and a higher productivity are made possible, since improved quality control in the form of improved control of the amount of inclusions and the casting structure can be combined with increased availability and higher casting speed.

CLAIMS

1. In the casting of metal, a method of controlling the flow of the molten metal in non-solidified portions of a cast strand, wherein a mould (11) is supplied, directly or through a casting tube (12), with at least one primary flow (20) of hot inflowing molten metal and at least one cast strand (1) is formed in the mould, whereby at least one static or period low-frequency magnetic field (10) is generated by means of magnetic poles (15), permanent magnets or coils supplied with direct current, which are arranged adjacent to the mould, and the static magnetic field is applied to act with a maximum magnetic field strength in the mould exceeding 1000 Gauss in the path of the inflowing molten metal to brake and split up the primary flow (20) of molten metal flowing into the mould and to control secondary flows (21, 22) arising, **characterized in that** the static magnetic field (10) is applied to act over essentially the whole width (W) of the cast strand (1) formed in the mould, whereby the magnetic field strength in a plane across the casting direction, on a level with the centre of the range of action of the magnetic field (10), varies within an interval of 60 to 100 per cent of its maximum value while at the same time the field strength on a level with the upper surface/the meniscus of the molten metal has a maximum value of 500 Gauss.

2. A method according to claim 1, **characterized in that** the magnetic field (10) is controlled and distributed to act with a maximum field strength in the mould amounting to between 1000 and 2000 Gauss.

3. A method according to claim 1 or claim 2, **characterized in that** the magnetic field (10) is controlled and distributed to act with the centre of its range of action arranged at a distance (H) of 300 to 600 mm below the upper surface/meniscus (13) of the molten metal,

to control the flow of the molten metal in non-solidified portions of the cast strand (1).

4. A method according to any of the preceding claims, **characterized in that** the magnetic field (10) is controlled and distributed by arranging the magnetic poles (15) movable and/or with adjustable core elements (19).

5. A method according to claim 4, **characterized in that** the intensity and propagation of the static magnetic field (10) are controlled and distributed by means of adjustable core elements (19) arranged in or adjacent to the magnetic poles (15), the core elements consisting of both magnetic and non-magnetic sections which are alternately inserted into or adjacent to the magnetic poles to control intensity and propagation of the magnetic field generated by means of the magnetic pole.

6. A method according any of the preceding claims, **characterized in that** the magnetic field (10) is distributed to act over essentially the whole width (W) of the cast strand (1) formed in the mould by means of a pole plate (16) which is arranged near the wall of the mould (11).

7. In the casting of metal, a device for controlling the flow of the molten metal in non-solidified portions of a cast strand, wherein a mould (11) is adapted to be supplied, directly or through a casting tube (12), with at least one primary flow (20) of hot inflowing molten metal and to form at least one cast strand (1), magnetic poles (15), permanent magnets or coils supplied with direct current being arranged adjacent to the mould to generate at least one static or periodic low-frequency magnetic field (10) with a magnetic field strength in the mould amounting to a maximum value exceeding 1000 Gauss, to act in the path of the inflowing molten metal and thereby to brake and divide the primary flow (20) of molten metal flowing into the mould (11) and to

control secondary flows arising, **characterized in that** the magnetic poles (15) are arranged to be movable and/or provided with adjustable core elements (19) to distribute the static magnetic field (10) to act over essentially the whole width (W) of the cast strand (1) formed in the mould, whereby the magnetic field strength of the applied magnetic field (10), in a plane across the casting direction, on a level with the centre of the range of action of the magnetic field (10), the pole centre, varies within an interval of 60 to 100 per cent of its maximum value while at the same time the magnetic field strength on a level with the upper surface/the meniscus of the molten metal amounts to 500 Gauss.

8. A device according to claim 7, **characterized in that** the magnetic poles (15) are arranged with their pole centre at a distance (H) of 300 to 600 mm below the upper surface/meniscus (13) of the molten metal.

9. A device according to claim 7 or claim 8, **characterized in that** the magnetic poles (15), in the form of induction coils (15a) supplied with direct current, are arranged with adjustable core elements (19) in the form of both magnetic and non-magnetic sections and that the core elements are adapted to be alternately inserted into the core (151) of the coil to change the magnetic field (10).

10. A device according to claim 7 or claim 8, **characterized in that** said magnetic poles (15) are arranged in the form of permanent magnets (15b) and a pole core (152) arranged between the permanent magnet (15b) and the mould (11), and that the pole core is arranged with adjustable core elements (19) in the form of both magnetic and non-magnetic sections and that core elements are adapted to be alternately inserted into the pole core (152) to change the magnetic field (10).

11. A device according to any of claim 7 to claim 10, **characterized in that** the magnetic poles (15) are arranged in the water box beams (14) of the mould.

12. A device according to any of claim 7 to claim 10, **characterized in that** the magnetic poles (15) are arranged between the water box beams (14) of the mould and a frame structure (17) surrounding the water box beams of the mould.

13. A device according to any of claim 7 to claim 12, **characterized in that** a magnetic return path (18) is arranged in a frame structure (17), surrounding the water box beams (14) of the mould, to constitute a magnetic circuit together with the magnetic poles (15) and the magnetic field (10) acting between the magnetic poles.

14. A device according to any of claim 7 to claim 13, **characterized in that** a pole plate (16) is arranged near the wall of the mould (11) to distribute the static magnetic field (10) over essentially the whole width (W) of the cast strand (1) formed in the mould.

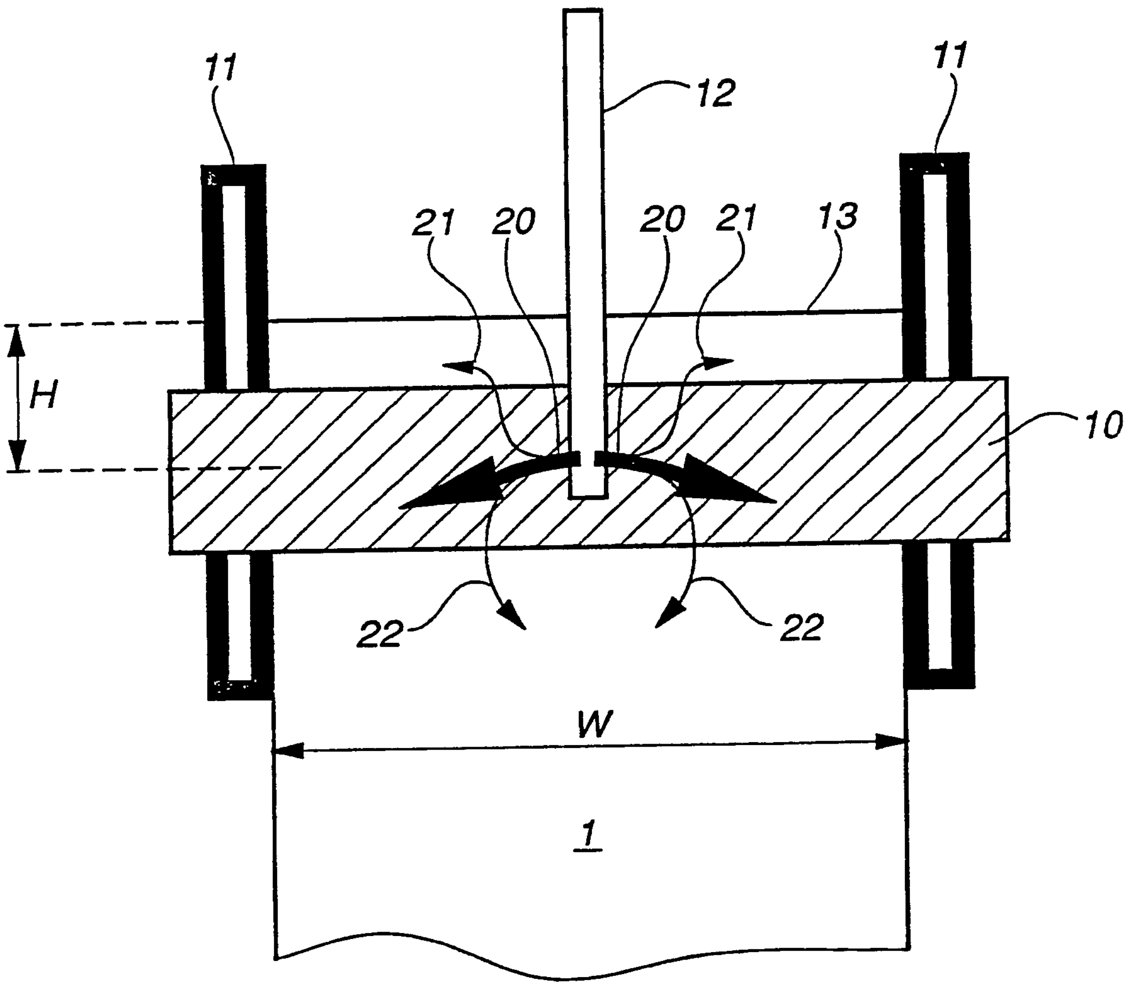
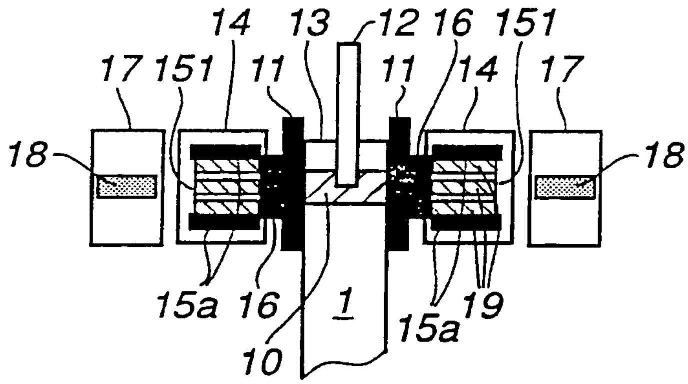


FIG. 1


14
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1
15a
19
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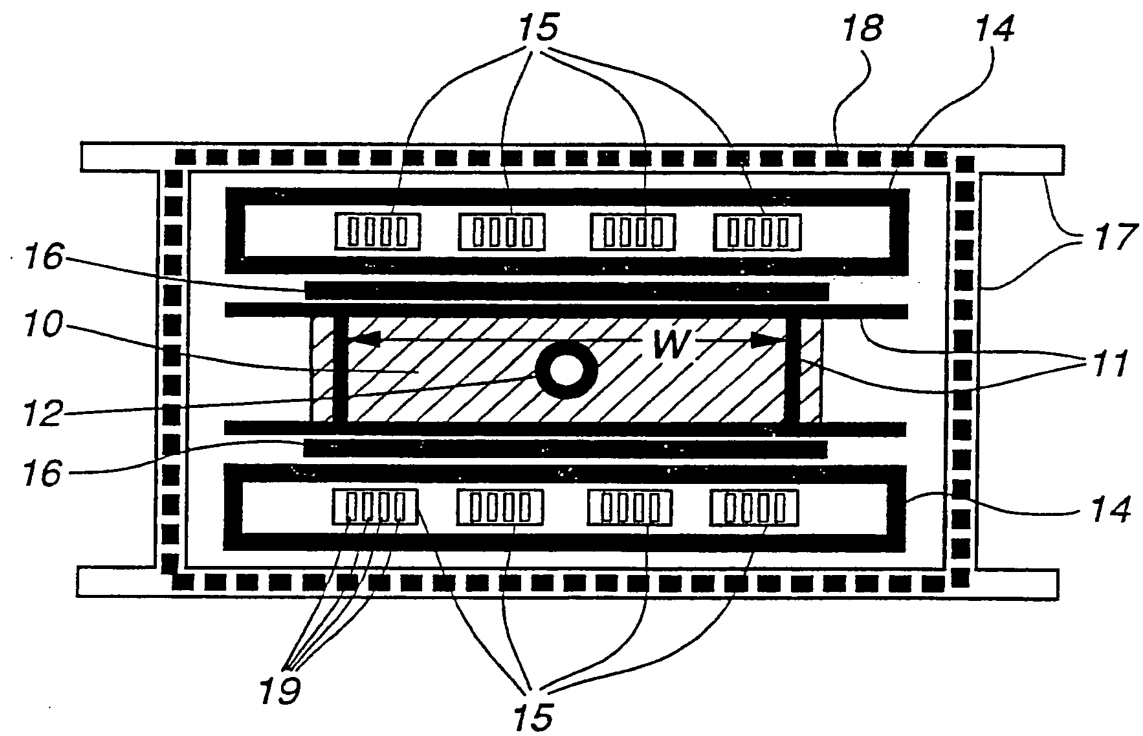
FIG. 3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W
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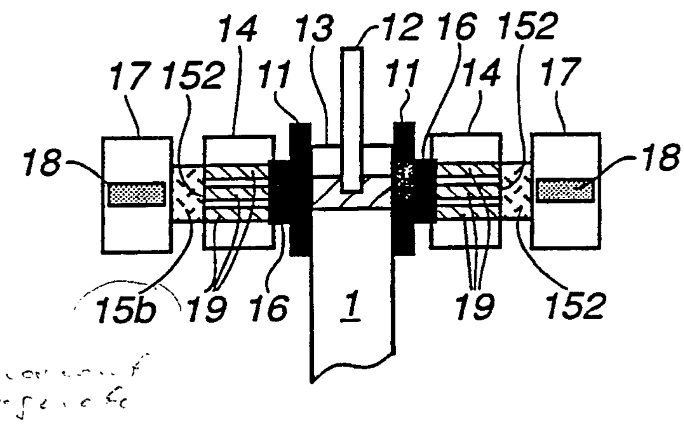
FIG. 2

3/3


14
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18
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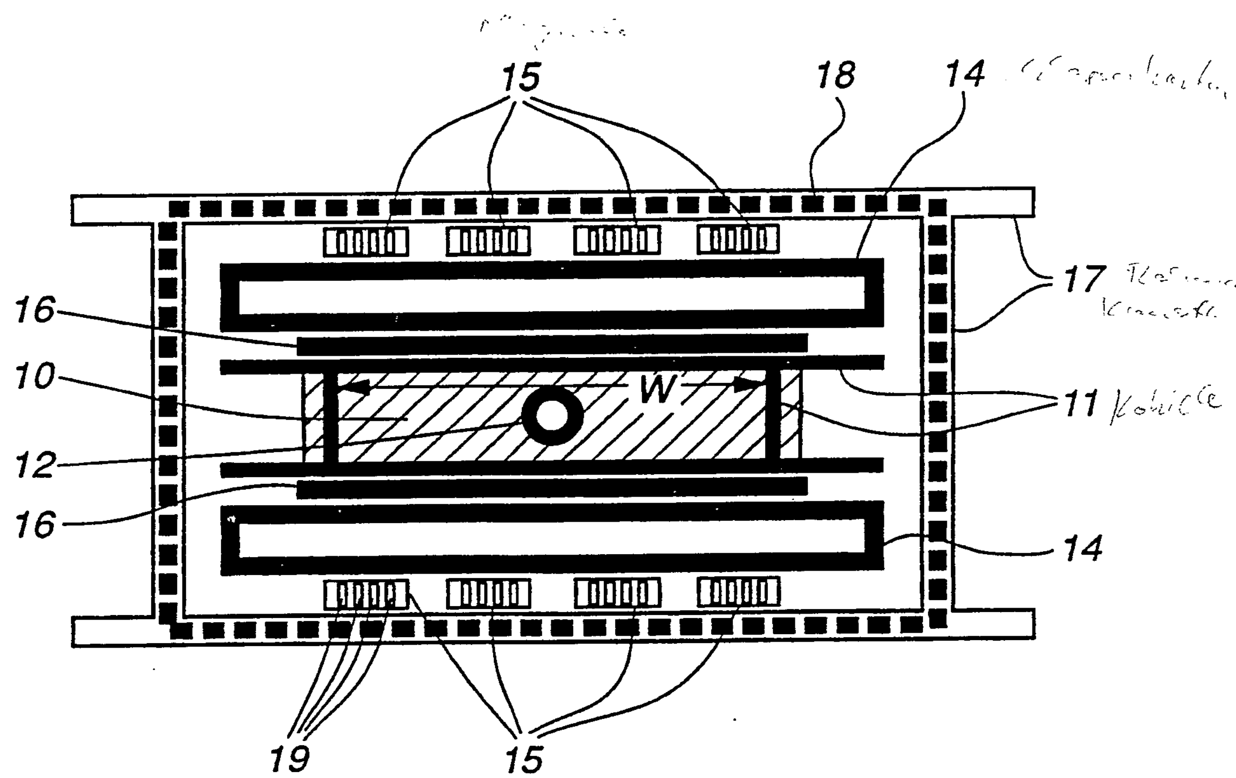
15b
19
16
1
19
152

FIG. 5


15
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19
15

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00025

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 22 D 11/10

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 22 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	Patent Abstracts of Japan, Vol 12, No 343, M741, abstract of JP 63-104758, publ 1988-05-10 (NIPPON KOKAN K.K.) --	1,7
A	Patent Abstracts of Japan, Vol 11, No 348, M642, abstract of JP 62-130752, publ 1987-06-13 (KAWASAKI STEEL CORP) --	1,7
A	EP, A2, 0401504 (KAWASAKI STEEL CORPORATION) 12 December 1990, see column 5, line 35 - line 44; figures 7,12 --	1,7
P	WO, A1, 9112909 (NIPPON STEEL CORPORATION) 5 September 1991, see abstract --	1,7

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
13th May 1992	1992 -05- 15
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Ulf Nyström

International Application No. PCT/SE 92/00025

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
P	EP, A1, 0445328 (NKK CORPORATION) 11 September 1991, see abstract --	1,7

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 92/00025

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 28/03/92
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A2- 0401504	90-12-12	AU-D-	5399090	90-11-08
		JP-A-	2284750	90-11-22
		JP-A-	3142049	91-06-17
WO-A1- 9112909	91-09-05	JP-A-	3248745	91-11-06
		JP-A-	3258442	91-11-18
EP-A1- 0445328	91-09-11	US-A-	5033534	91-07-23

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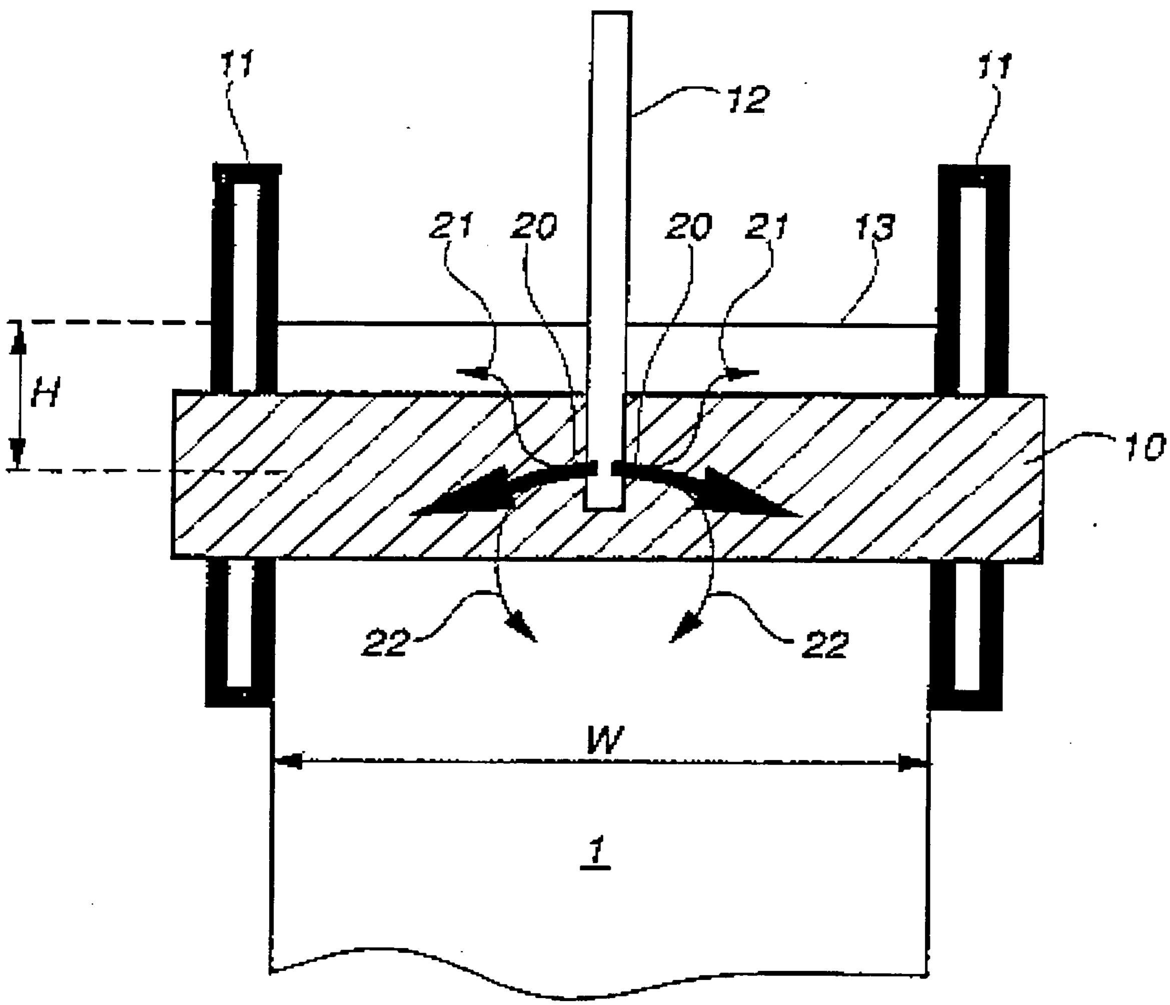

FIG. 1

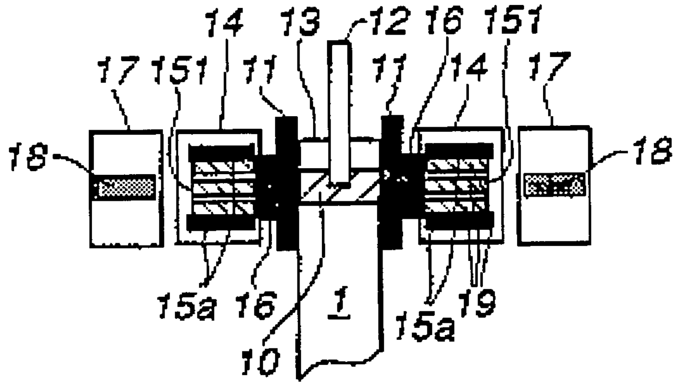
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FIG. 3

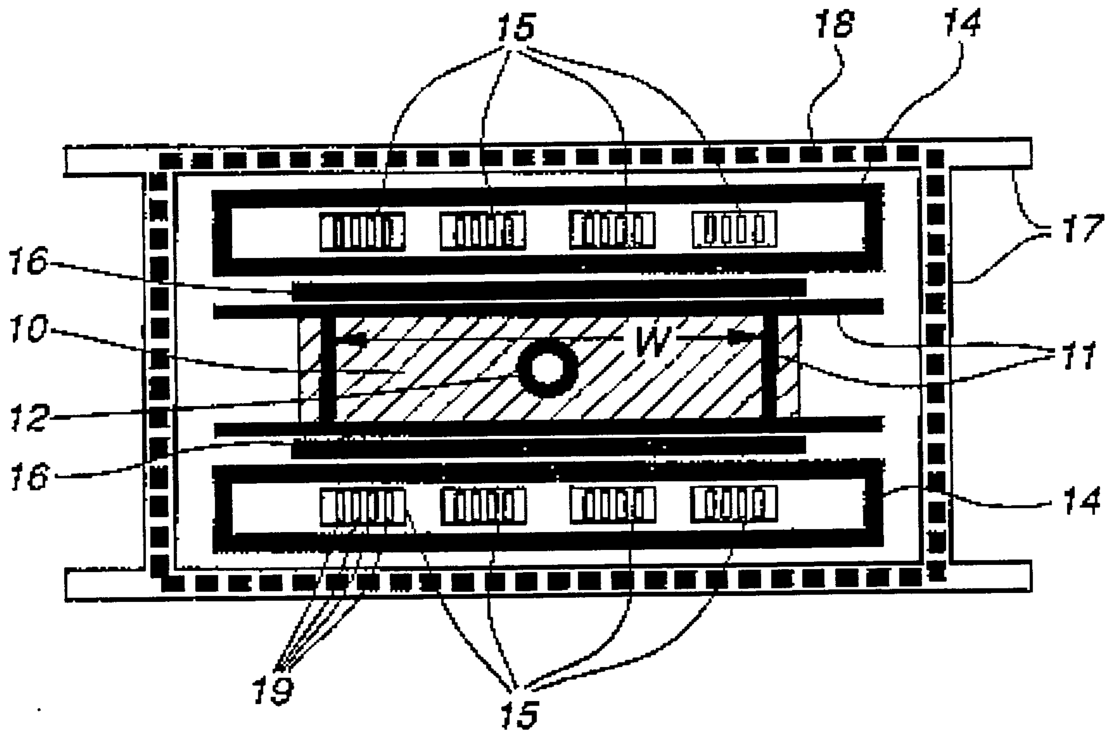
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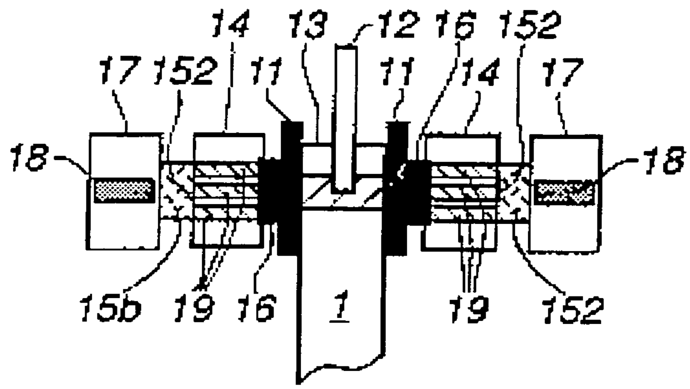
FIG. 2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152

FIG. 5

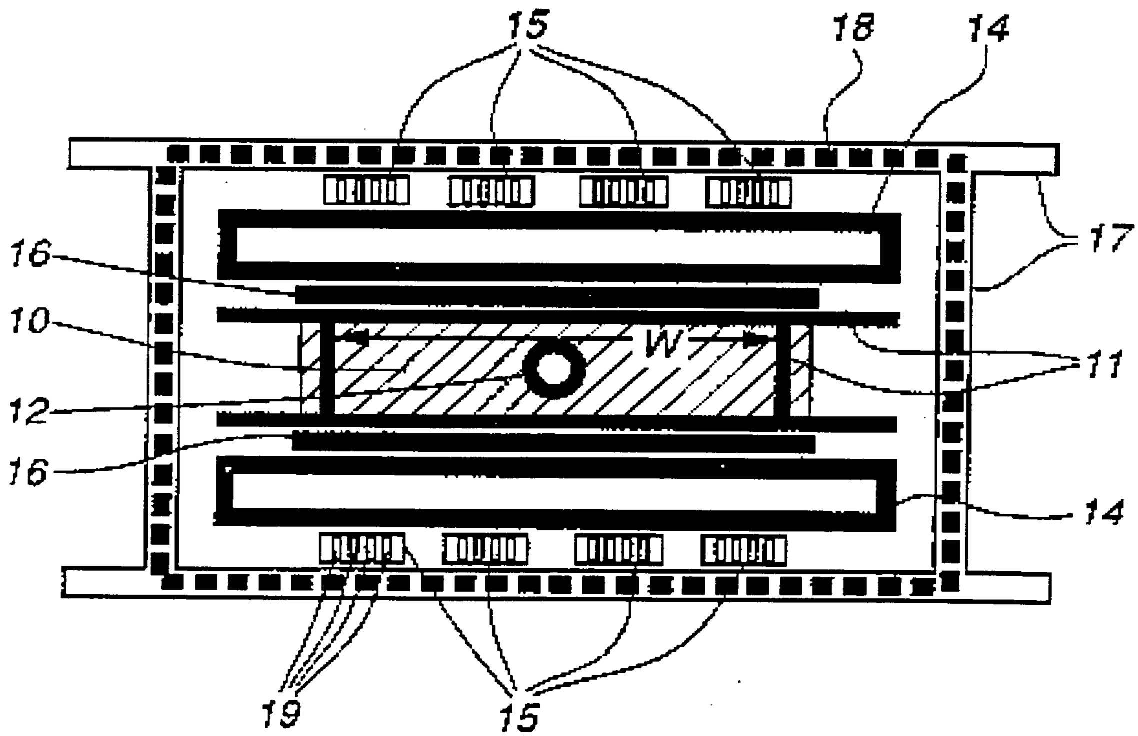
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FIG. 4